NOTES 14: P-VALUES AND SIGNIFICANCE

Stat 120 | Fall 2025

Prof Amanda Luby

Last time, we laid out the following steps for setting up a hypothesis test:

- 1. Formulate hypotheses in terms of population parameter
- 2. Collect data and compute a sample statistic
- 3. Use the sample statistic to make a claim about the hypotheses

Today, we're diving into step 3:

- 3a. Construct null distribution
- 3b. Compute p-value
- 3c. Make a decision about H_0

0.1 For our study on F's

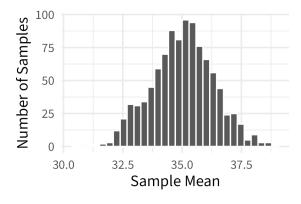
Population parameter: μ

Sample statistic: \bar{x}

 $H_0: \mu = 35$

 $H_A: \mu < 35$

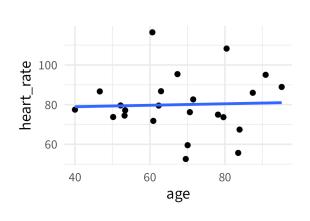
Null Distribution:



How do we construct a null distribution?

StatKey Example: In a random sample of 765 adults in the United States, 322 say they could not cover a \$400 unexpected expense without borrowing money or going into debt. A journalist claims that this is evidence that the overall proportion could be 50%. Is the journalist justified?

R "Paper" Example: A public health researcher believes that there is a positive relationship between heart rate and age among ICU patients. Data from 23 patients gives r=0.037.



```
# A tibble: 23 x 2
     age heart_rate
   <dbl>
              <dbl>
    70.7
                76.2
    87.4
                86.0
 3
    67.3
               95.4
    80.4
              108.
    95.1
               88.9
    60.7
              116.
 7
    83.9
               67.4
    79.6
               73.7
 8
    90.9
               95.0
 9
10
    62.3
               79.5
# i 13 more rows
```

```
library(CarletonStats)
permTestCor(heart_rate ~ age, data = icu, alternative = "greater")
```

** Permutation test **

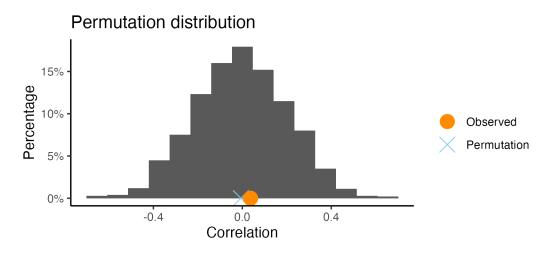
Permutation test with alternative: greater

Observed correlation between age , heart_rate : 0.037

Mean of permutation distribution: -0.00652

Standard error of permutation distribution: 0.2069

P-value: 0.413



R Example: In a pre-Musk Pew Research Poll on social media use, 72% of Twitter users (n = 346) responded that they visited Twitter a few times a week or more. Among Instagram users (n = 530), this number was 80%. Is there a difference in frequency of use between Twitter and Instagram users?

permTest(visits ~ app, data = social_media)

** Permutation test **

Permutation test with alternative: two.sided

Observed statistic

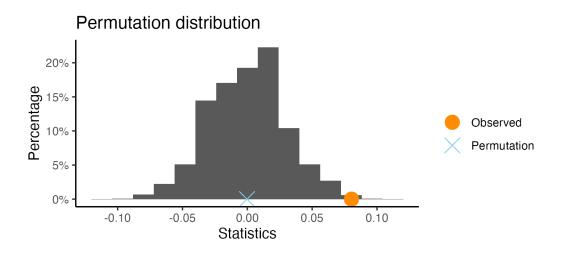
instagram: 0.8 twitter: 0.7197

Observed difference: 0.08035

Mean of permutation distribution: -0.00025

Standard error of permutation distribution: 0.02929

P-value: 0.004



1 Statistical Significance

Significance Level
Statistical Significance
Formal Statistical Decisions

2 Summary

Whenever performing a hypothesis test, you should:

- (1) Perform an appropriate EDA
- (2) Formulate ${\cal H}_0$ and ${\cal H}_A$
- (3) Compute a test statistic
- (4) Construct a null distribution
- (5) Compare the test statistic to the null distribution and compute a p-value
- (6) Make a decision (reject or fail to reject) about ${\cal H}_0$
- (7) Report your conclusion in context